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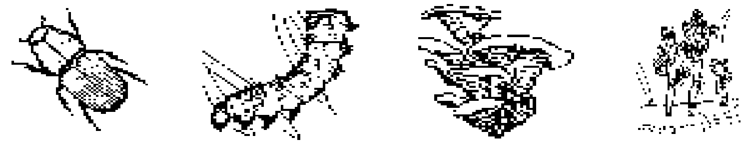

Report 02-5 **April 2002**

DOUGLAS-FIR TUSSOCK MOTH BIOLOGICAL EVALUATION PALOUSE RANGER DISTRICT, CLEARWATER NATIONAL FOREST - 2001

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Douglas-fir tussock moth (DFTM) periodically reaches outbreak levels in forested lands of the Palouse Ranger District, Clearwater National Forest. In 2000, the first aerially visible defoliation was recorded on the District since 1986. Defoliation in 2000 covered approximately 54,000 acres around Moscow Mountain and in McCrosky State Park. In 2001, approximately 141,900 acres of DFTM defoliation were mapped on aerial survey maps. The majority of defoliation in both 2000 and 2001 occurred on state and privately owned lands. The Palouse Ranger District administers all National Forest System (NFS) land involved.

The 2000-2001 DFTM outbreak is the fifth in this area since the 1940's. Outbreaks have generally been 10 years apart, and have resulted in 1-2 years of visible defoliation.

Most of the area defoliated in 2000, was defoliated again in 2001 with the exception of Mica Mountain. Most additional acres defoliated in 2001 were adjacent to areas defoliated in 2000. On NFS ground in 2001, new defoliation occurred as predicted from Gold Hill to Prospect Peak/Crane Point (T42 –43N, R3-4W) and in scattered patches in the vicinity of Schwartz Creek and Vassar Meadows (T41N R2W) (Randall 2001). An additional new patch of defoliation was mapped north of Bovill (T42-43N, R2W-1E). The area north of Bovill was not sampled extensively in the fall of 2000, and when visited in 2001, defoliation was mostly of light intensity and was due to a combination of DFTM and hemlock looper, another native defoliator.

The visible defoliation experienced in 2000 and 2001 indicates that the DFTM population likely reached its peak in 2001. Based on ground surveys, we anticipate that there will be additional defoliation in 2002; however, none of the surveys conducted in the fall of 2001 found areas on NFS land with DFTM populations as large as those conducted in the fall of 2000 in the most heavily defoliated areas in 2001.

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In the areas examined in 2001, only the Gold Hill to Prospect Peak Forest Service parcel had DFTM egg masses in sufficient numbers over a large enough area that we would expect widespread defoliation, yet natural early instar larval mortality in this area rivaled those of areas treated with insecticides in 2001. Plots on NFS lands inside McCrosky State Park had new egg masses, but the majority of the state park was treated with insecticide in 2001 so defoliation in 2002 should be confined to small, scattered NFS parcels and is not expected to be severe.

Idaho Department of Lands conducted a cooperative DFTM aerial suppression project on 76,492 acres of state and private land in the spring of 2001. No NFS lands were treated in this project.

INTRODUCTION

Douglas-fir tussock moth (DFTM) periodically reaches outbreak levels in forested lands of the Palouse Ranger District, Clearwater National Forest. In 2000, the first aerially visible defoliation was recorded on the District since 1986. Defoliation in 2000 covered approximately 54,000 acres around Moscow Mountain and in McCrosky State Park. In 2001, approximately 141,900 acres of DFTM defoliation were mapped on aerial survey maps. The majority of defoliation in both 2000 and 2001 occurred on state and privately owned lands. Palouse Ranger District administers all National Forest System (NFS) land involved.

The purpose of this biological evaluation is to update information in "Douglas-fir tussock moth biological evaluation, Palouse Ranger District, Clearwater National Forest-2000" (Randall 2001), to quantify and document 2001 defoliation, to assess current tussock moth populations, and to project defoliation impacts.

In 2001, the State of Idaho conducted an aerial suppression program on much of the state and private land defoliated in 2000. The spray project treated 76,492 acres. No NFS lands were treated in this project. Instead, the Palouse Ranger District opted to monitor the DFTM population levels and defoliation and respond silviculturally if damage resulted in unacceptable loss.

METHODS

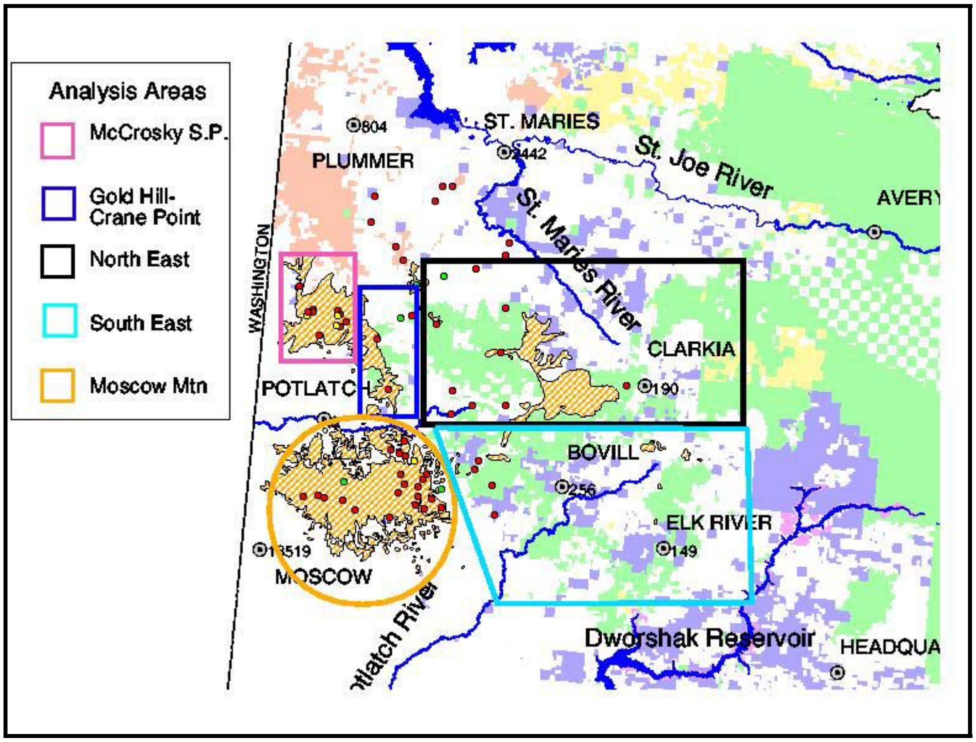
Data Sources

A number of information sources are available to help characterize DFTM damage and population levels on NFS land administered by Palouse Ranger District in 2001. Data sources include aerial detection surveys conducted by Idaho Department of Lands personnel and digitized by Forest Health Protection personnel, DFTM early warning system pheromone trapping data collected by Idaho Department of Lands and Forest Health Protection, 10 minute timed egg mass surveys in fall 2000, larval reduction rates for four control plots established on NFS lands to help assess larval mortality rates associated with the State of Idaho DFTM spray project, and the incidence of nucleopolyhedrosis virus, a primary cause for DFTM population collapse. In addition to these information sources, 65 semi-permanent plots were established in areas of concern in the fall of 2001.

Analysis Areas

For the purpose of data analysis, the outbreak area was divided into five analysis areas based on 2000 defoliation, 2000 egg mass survey results, and early warning pheromone trap results from 1997-2000. The five analysis areas are McCrosky State Park, Gold Hill to Crane Point, Moscow Mountain to Stanford Point, North East, and South East (Figure 1). A sixth analysis area was created when pheromone trapping results in 2001 identified a new area with high pheromone trap counts south and east of the existing five analysis areas (Bald Mountain/ Bargamin Creek (T33-37N, R4-5E)) (Figure 2).

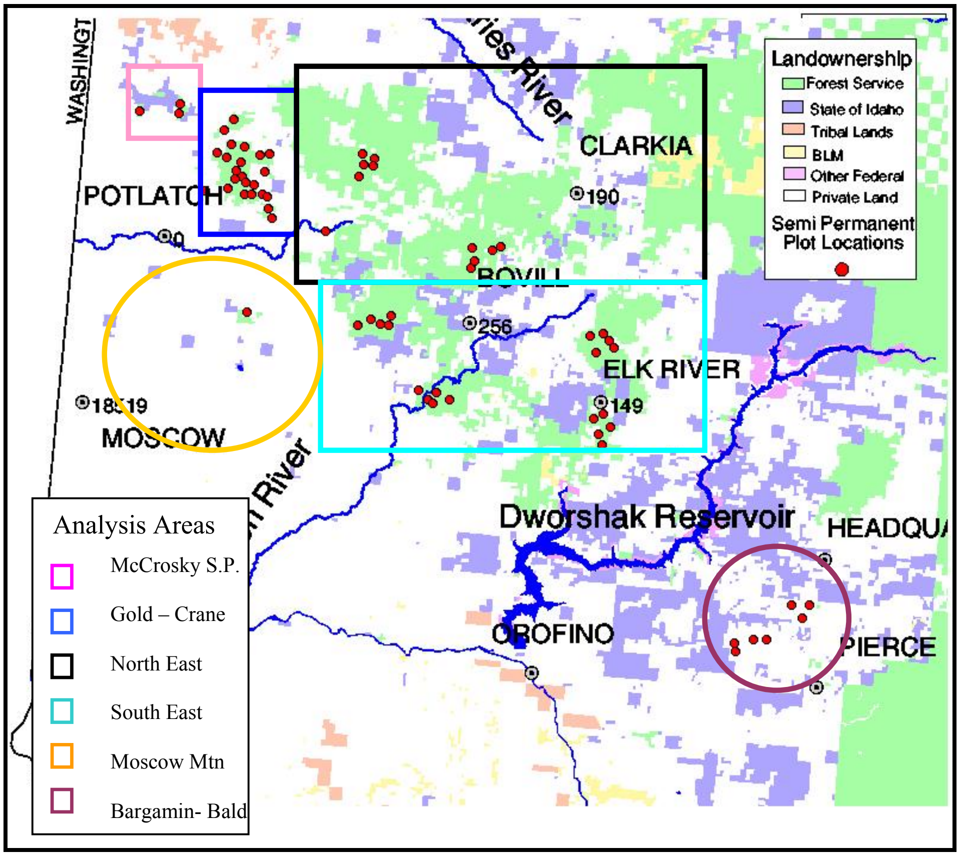
Figure 1. DFTM Analysis Area Boundaries on the Palouse Ranger District, Clearwater National Forest. Dots on maps are DFTM Early Warning System trap sites results in 2001. Red dots exceeded threshold (>= 25 male moths/ trap), yellow dots had between 1 and 25 male moths/trap, and green dots had 0 male moths/trap.



Semi-permanent Plots

Fifty-eight semi-permanent plots were established at a density of 1 plot per section on prioritized NFS lands administered by the Palouse Ranger District including (1) Gold Hill–Prospect Peak/Crane Point analysis area (23 plots); (2) NFS lands in McCrosky State Park analysis area (3 plots); (3) NFS lands in Moscow Mountain analysis area (Brown's Meadow) (1 plot); (4) NFS lands in the North East (11 plots) and (5) South East (20 plots) analysis areas. Seven semi-permanent plots were established on private lands in the Bargamin Creek/Bald Mountain analysis area (Appendix 1, Figure 2).

Figure 2. Fall 2001 Semi-permanent Plot Locations and Analysis Area Boundaries.



Plots were located in areas close to roads and, if possible, with visible DFTM defoliation. Plot center was located in the center of visible defoliation or in the center of a group of suitable host trees. After identifying plot center, three entire lower branches from 20 host trees > 4" (10 cm) d.b.h. nearest plot center were examined. All current (2001) egg masses were counted (Shepherd et al. 1984) as well as older (2000 and prior) hatched egg masses and cocoons.

Defoliation estimates using Wickman's (1979) 7-class defoliation system (Table 1) were made on the 20 trees sampled for egg masses and on 15 understory trees in the 2 4 "(5-10 cm)" d.b.h. range near plot center. Wickman's classes 1 and 2 are considered light defoliation, and classes 3-7 are considered moderate to heavy defoliation.

Table 1. Visual defoliation estimate classes based on Wickman (1979)

Defoliation Class	Description
1	(10 percent) Top 10 percent of the crown (mostly new foliage) is totally defoliated. Additional defoliation of new foliage may occur lower in the crown, but branches are not completely stripped.
2	(25 percent) Branches are completely stripped of needles in the top quarter of the crown. This crown area is mostly new foliage, but some feeding on older foliage may also occur at this level. Most new foliage is removed in the lower crown.
3	(50 percent) The top half of the crown is totally defoliated. There is significant feeding on older needles at this level of defoliation. All new foliage is damaged in the lower crown.
4	(75 percent) The top three-quarters of the crown is totally defoliated. There is heavy feeding on older foliage and all new foliage is removed from the remainder of the crown. The crown may take on a very ragged or uneven appearance below the area of total defoliation.
5	(90 percent) Green needles remain on only the lowest 10 percent of the crown. Sometimes only the lower whorl of branches is left with green needles.
6	(99 percent) The tree may only have a few green needles remaining on one of the lower branches.
7	(100 percent) Trees are completely stripped of foliage. There may be some stubs of green needles remaining, but those will eventually be lost. At this level of defoliation even the new buds may be eaten.

The semi-permanent plots were sampled for egg masses, cocoons, and defoliation in the fall of 2001, and will be sampled in 2002 for early instar larvae, defoliation, egg masses and cocoons.

Early Warning System Pheromone Trapping Trends

Methods for this portion of the analysis are located in Appendix 2.

Early Larval Population Sampling

Idaho Department of Lands established four control sites on NFS lands in the spring of 2001 to evaluate effectiveness of spray operations—one in McCrosky State Park analysis area, one in the Moscow Mountain analysis area, and two in the Gold Hill-Prospect Peak/Crane Point analysis area. Lower crown beating was conducted to characterize populations of early instar larvae before (within 72 hours) and after (15 to 25 days) insecticide application. In each control plot, three lower crown branches from each of five trees were sampled. The 18-inch outer branch tips were tapped with a beating stick while a beating cloth was suspended below the branch. The total number of larvae dislodged from the branch tip and landing on the beating cloth was counted for each plot.

Egg Mass and Cocoon Surveys

In the fall of 2000, egg mass surveys were conducted using a 10-minute timed survey. On the 65 semi-permanent plots in 2001, we used a system developed by Shepherd, Otvos, and Chorney (1984) in which three entire lower crown branches are sampled per tree. We switched to the new system because it enabled us to predict defoliation in plots not currently defoliated based on number of current egg masses found in the lower crown. We also counted older egg masses and cocoons (which could be from current year or older—there was no reliable way to differentiate between the two). These additional

pieces of information allowed us to consider the relationship between cocoons, egg masses, and defoliation intensity in plots that experienced defoliation in 2001 (Appendix 3).

Predicted Population Trends, Current to Older Egg Mass Ratios

The ratio of new to old (last season's) egg masses was used to predict DFTM population trends. A ratio above 1 indicates an increase in egg masses and an increasing population; a ratio below 1 indicates populations are likely decreasing, and a ratio of 1 indicates static populations. Plots with no old egg masses and current egg masses were assumed to have increasing DFTM populations. If a number of plots in an analysis area have increasing population trends, there is a greater likelihood that DFTM damage will be more pronounced than the previous year.

RESULTS

2001 Defoliation Summary

Aerial Detection Survey DFTM Defoliation Summary

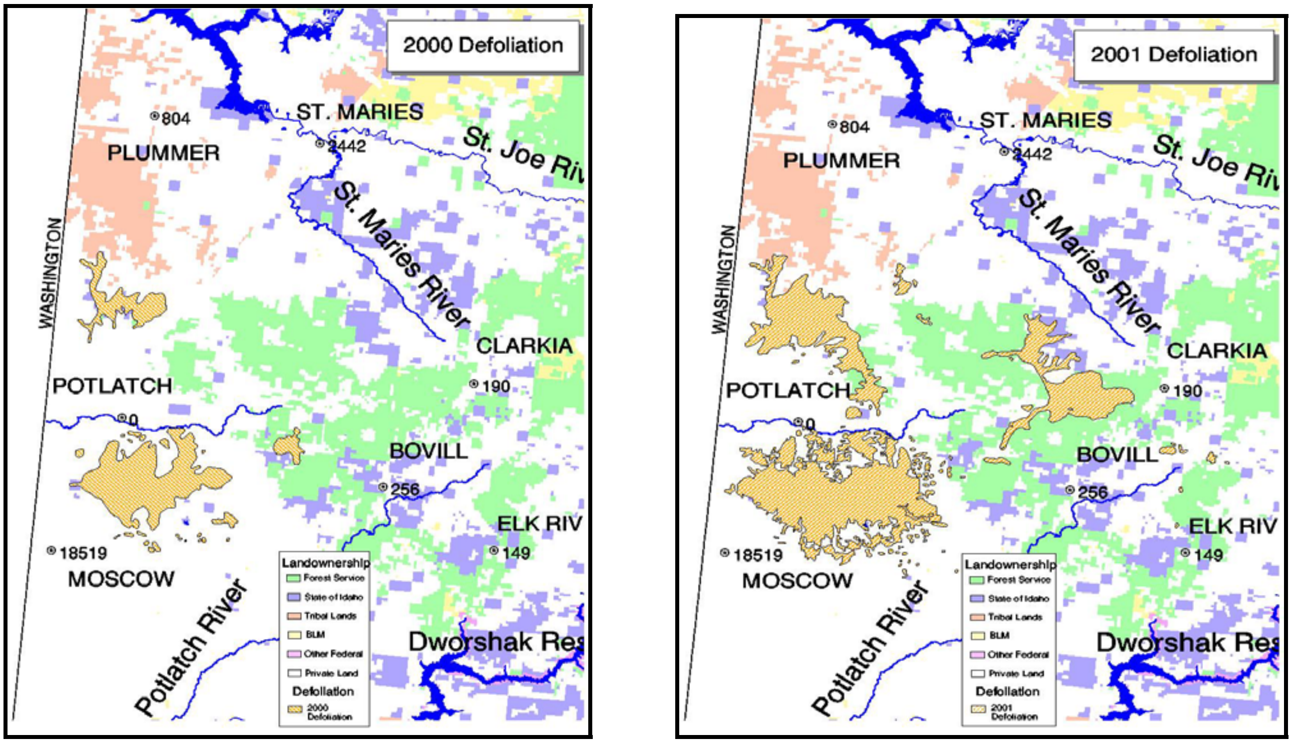
DFTM defoliation was summarized using aerial detection surveys (ADS). Most of the defoliation in 2000 and 2001 occurred on state and private land (Table 2). The proportion of defoliation on NFS lands increased from 5% to 18% from 2000 to 2001. Most of the area defoliated in 2000 was defoliated again in 2001 with the exception of the area around Mica Mountain (Figure 3). Most additional acres defoliated in 2001 were adjacent to areas defoliated in 2000. On NFS ground in 2001, new defoliation occurred as predicted from Gold Hill to Prospect Peak Crane Point (T42 –43N, R3-4W) and in scattered patches in the vicinity of Schwartz Creek and Vassar Meadows (T41N R2W) (Randall 2001). An unpredicted patch of defoliation was mapped north of Bovill (T42-43N, R2W-1E).

Table 2. Aerial detection survey estimated Douglas-fir tussock moth defoliation summary for 2000 and 2001 by land ownership.

Land Owner	2000 (% of Total)	2001 (% of Total)
Forest Service Total*	2650 (5%)	24895 (18%)
St. Joe NF	191 (<1%)	13,934 (10%)
Clearwater NF	2,369 (4%)	10,961 (7%)
BLM	0 (0%)	100 (<1%)
Coeur D'Alene Tribe	61 (<1%)	1,236 (1%)
State	6,852 (13%)	11,340 (8%)
Private	44,056 (82%)	104,301 (74%)
TOTAL Acres	**53,529**	**141,872**

*All affected Forest Service lands are administered by the Palouse Ranger District, Clearwater National Forest.

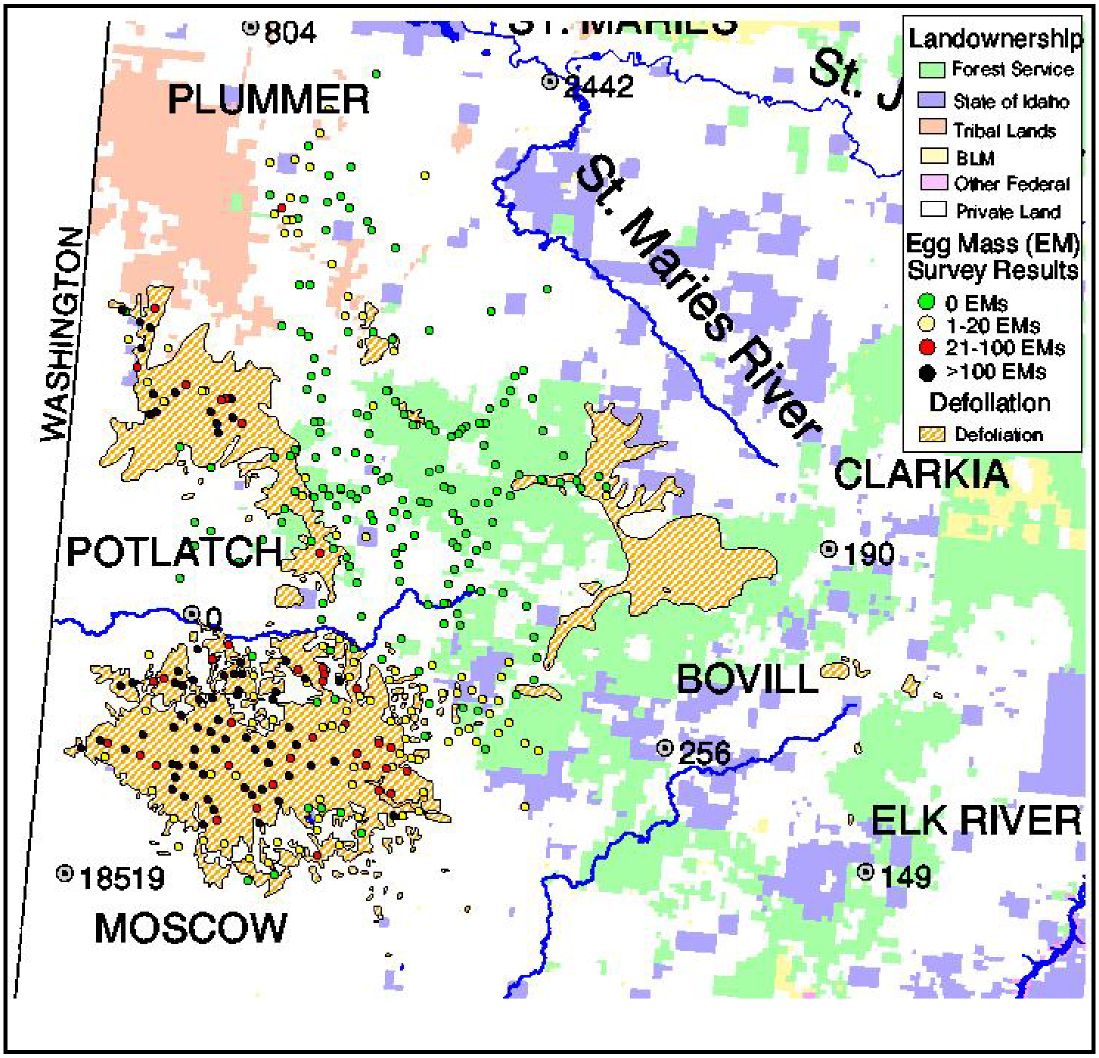
Figure 3. Douglas-fir tussock moth defoliation mapped by aerial detection survey in 2000 and 2001.



ADS surveys did not differentiate between lightly and heavily defoliated areas. Ground observations on NFS lands found the vast majority of defoliated acres were lightly defoliated. Moderate and heavy defoliation was observed on NFS land on the Palouse Ranger District in widely scattered, fairly small (2-50 acre) patches in McCrosky State Park, Moscow Mountain, and Gold Hill-Crane Point analysis areas. Ground observations in the defoliated area north of Bovill in 2001 found mostly light defoliation caused by a combination of DFTM and hemlock looper, another native defoliator.

The most severely defoliated areas in 2001 were the areas in which egg mass surveys in the fall of 2000 found most egg masses (Figure 4). Heaviest defoliation was concentrated in Moscow Mountain and McCrosky State Park analysis areas. An area mostly on private land on the south side of Gold Hill also experienced moderate to severe defoliation in 2001.

Figure 4. Fall 2000 DFTM egg mass survey points and results and summer 2001 DFTM defoliation from aerial detection survey.



2001 Plot Level Defoliation Summaries

Tree level defoliation ratings of 1 or greater using Wickman's (1979) rating system (Table 1) only occurred on overstory trees in 15 of the 65 semi-permanent plots, and on understory trees in 10 of the 65 semi-permanent plots (Tables 3 and 4). No defoliation was recorded for overstory trees in the Bargamin Bald or North East analysis areas or for understory trees in the Bargamin Bald, North East, or South East analysis areas. None of the semi-permanent plots had a sample tree with a defoliation rating of 7, or 100%, and only one plot had understory trees with a rating of 6, or 99%.

Table 3. Plot level defoliation summaries by analysis area for overstory trees measured on the 65 semi-permanent plots.

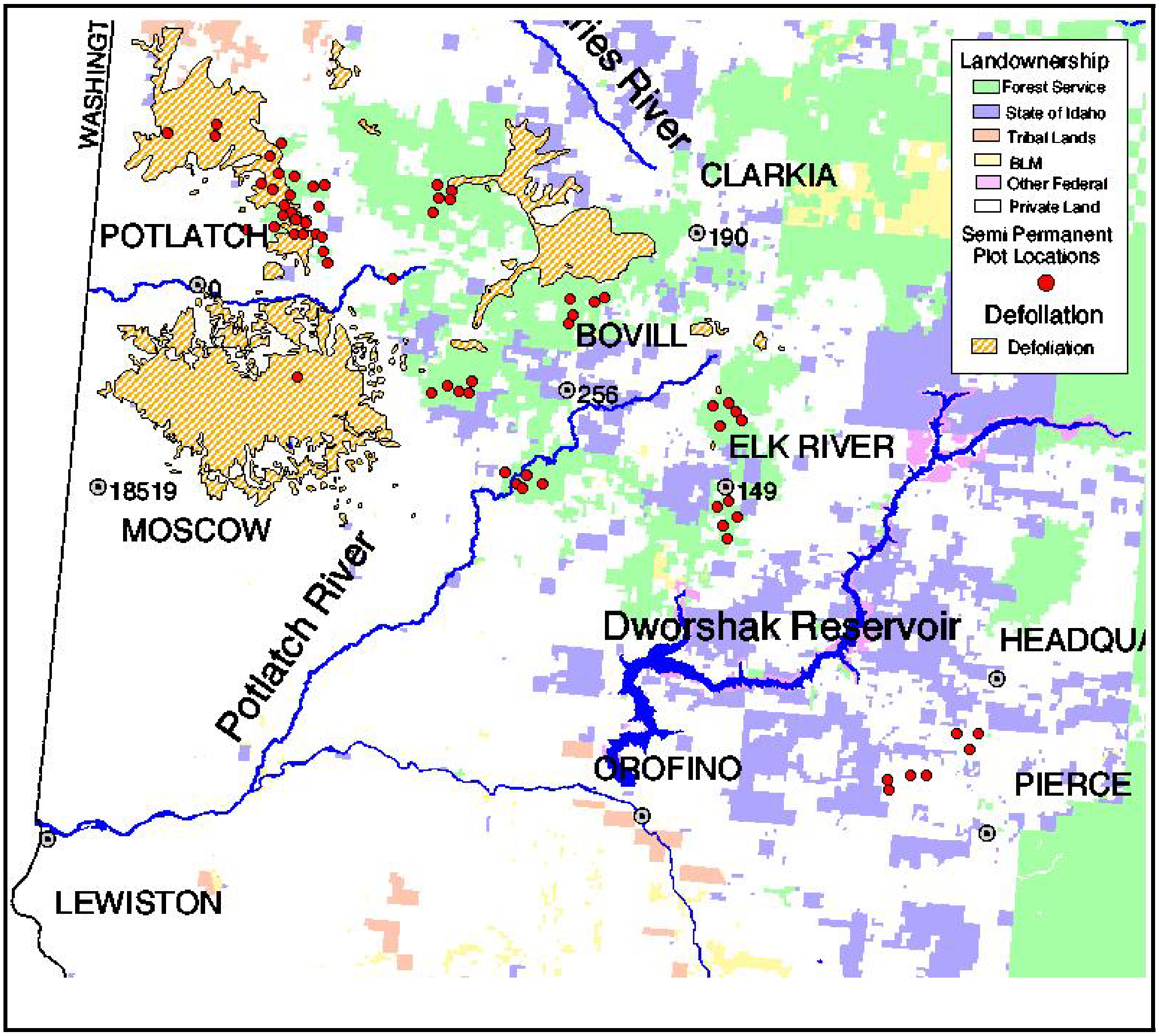
Analysis Area	Total # Plots	# Plots Defoliated	Defoliation Rating						
			0	1	2	3	4	5	6
Bargamin Bald	7	0	7	0	0	0	0	0	0
Gold Hill- Crane Point	23	8	22	7	7	4	2	1	0
McCrosky State Park	3	3	3	3	3	3	0	1	0
Moscow Mountain	1	1	1	1	0	1	0	0	0
North East	11	0	11	0	0	0	0	0	0
South East	20	3	20	3	1	1	0	0	0

Table 4. Plot level defoliation summaries by analysis area for understory trees measured on the 65 semi-permanent plots.

Analysis Area	Total # Plots	# Plots Defoliated	Defoliation Rating						
			0	1	2	3	4	5	6
Bargamin Bald	7	0	7	0	0	0	0	0	0
Gold Hill- Crane Point	23	6	23	6	6	6	1	0	1
McCrosky State Park	3	3	2	3	3	3	3	0	0
Moscow Mountain	1	1	1	1	0	1	0	0	0
North East	11	0	0	0	0	0	0	0	0
South East	20	0	0	0	0	0	0	0	0

Semi-permanent plot locations overlapped with aerial survey delineated defoliation in 2001 for all plots in the McCrosky State Park analysis area, and the one plot in the Moscow Mountain analysis area. In the Gold Hill analysis area 11 of the 23 semi-permanent plots were located in 2001 aerial survey DFTM defoliation polygons. None of the semi-permanent plots in the North East, South East, or Bargamin-Bald analysis areas fell inside 2001 aerial survey DFTM defoliation polygons (Figure 5).

Figure 5. 2001 Aerial Survey DFTM Defoliation Boundaries and Semi-permanent Plot Locations.



Overstory Tree Defoliation Summaries

Ten percent of overstory trees in plots that experienced defoliation had moderate to severe ratings 3 (50-75% of top completely defoliated) or higher) Of these, 2% had a rating of 4 (75-90% of top completely defoliated; 4 trees) or 5 (90-99% of top completely defoliated, 1 tree). Forty-four percent had 0-10% of the top completely defoliated (rating = 0) (Table 5).

Table 5. The number of overstory trees by defoliation rating for plots that had sample trees with defoliation ratings > 0. There were a total of 20 overstory trees sampled per plot. A defoliation rating of 3 or higher is considered moderate to heavy defoliation.

Analysis Area	Plot #	Plot Name	Number of Trees by Defoliation Rating						
			0	1	2	3	4	5	6
Gold Hill- Crane Pt	11	Last Chance Creek	19	1					
	16	Treasure Gulch #1	3	14	1	2			
	17	Treasure Gulch #2	13	3	2	2			
	18	East Gold Trail #215	19	0	1				
	2	788E Gold Hill	11	6	3				
	21	Crane Point Jct	0	6	7	7			
	3	Olevan Creek	0	6	6	5	2	1	
	4	Waterhole Creek Trail #15	5	4	10		1		
McCrosky SP	22	McKrosky	3	14	2	1			
	25	Corinth Trail Head	2	7	9	2			
	26	Mission Mountain	4	3	8	4	1		
Moscow Mountain	27	Brown's Meadow	8	11	0	1			
South East	28	Corral Creek	9	5	4	2			
	54	Cougar Ranch	18	2					
	55	Little Bear Creek	19	1					

Gold Hill analysis area had the most heavily defoliated overstory trees (individual trees had highest ratings and more sample trees per plot had higher ratings) in defoliated semi-permanent plots sampled. No defoliation was noted in this analysis area in aerial surveys in 2000 (Figure 3). Twenty-three semi-permanent plots were established in this area in 2001. Of the 23, 11 were located inside 2001 aerial survey DFTM defoliation boundaries. Eight semi-permanent plots had overstory sample trees with 10% or more top defoliation. Three of the 8 plots had only lightly defoliated trees (defoliation ratings of 1 or 2). Of the five plots with trees moderately to heavily defoliated, three plots had 10% or less (2 of 20 sample trees) in these higher defoliation classes. The remaining two plots, Crane Point Junction and Olevan Creek, had at least 10% of the top defoliated on every sample tree. Crane Point Junction had 35% (7 sample trees) in defoliation class 3 and none in higher classes. Olevan Creek had 25% (five sample trees) in defoliation class 3, 10% (two sample trees) in defoliation class 4, and 5% (one sample tree) in defoliation class 5.

Both Moscow Mountain and McCrosky State Park analysis areas experienced defoliation in 2000 and 2001. We established fewer semi-permanent plots in these analysis areas than in the others because they contain little NFS land. All semi-permanent plots in these analysis areas had defoliated trees with ratings of 3 or greater. The one plot located in Moscow Mountain analysis area had only one overstory tree with a defoliation rating in the moderate-heavy category (rating =3). The highest defoliation rating in two of the three semi-permanent plots in McCrosky State Park was a 3, and in one plot only 5% (one sample tree); in the other only 10% (two sample trees) had this rating. In the third semi-permanent plot in McCrosky State Park analysis area four overstory trees (20%) had a rating of 3 and one (5%) had a rating of 4.

South East analysis area had three plots out of 20 with defoliated overstory trees. There was no aerially detected DFTM defoliation in this analysis area in 2001. Two of the three plots only had lightly defoliated trees with a rating of 1 (one sample tree in one plot (5%) and two sample trees in another

(10%)). The third plot, Corral Creek, had 11 of 20 sampled trees with defoliation. Two defoliated overstory trees in Corral Creek were rated 3. We suspect that defoliation in the three plots in the South East analysis area was due to hemlock looper or some other defoliator because there was little evidence of DFTM (in Corral Creek which had the highest defoliation rating, there were no current or old DFTM egg masses, and only three cocoons; less than the other two plots in this analysis area (see Egg Mass Cocoon Sampling section below)).

Understory Tree Defoliation Summaries

Twenty percent of understory trees in plots that experienced defoliation had moderate to severe defoliation ratings (3 or higher). Of these, 7% had rating of 4 (9 trees) or 6 (2 trees). Thirty-one percent had 0-10% of the top defoliated (rating = 0) (Table 6).

Table 6. The number of understory trees by defoliation rating for plots that had sample trees with defoliation ratings > 0. There were a total of 20 understory trees sampled per plot. A defoliation rating of 3 or higher is considered moderate to heavy defoliation.

Analysis Area	Plot #	Plot Name	Number of Trees by Defoliation Rating						
			0	1	2	3	4	5	6
Gold Hill- Crane Pt	16	Treasure Gulch #1	9	2	3	1			
	17	Treasure Gulch #2	6	7	1	1			
	2	788E Gold Hill	10	3	1	1			
	21	Crane Point Jct	1	7	4	3			
	3	Olevan Creek	5	3	1	3	1	0	2
	4	Waterhole Creek Trail #15	7	5	1	2			
McCrosky SP	22	McKrosky	1	3	8	2	1		
	25	Corinth Trail Head	1	8	1	2	3		
	26	Mission Mountain	0	2	5	4	4		
Moscow Mountain	27	Brown's Meadow	7	7	0	1			

With the exception of understory trees in Olevan Creek plot, Gold Hill analysis area, sampled understory trees in McCrosky State Park analysis area were the most heavily defoliated (individual trees had highest ratings and more sample trees per plot had higher ratings). All three semi-permanent plots in the McCrosky analysis area had understory trees with a defoliation rating of 4, and a minimum of 20% of understory sample trees having a rating of 3 or 4.

Five of the six semi-permanent plots with understory defoliation in Gold Hill analysis area had 3 as the highest defoliation rating, and of those plots only one had 20% of sample trees reach this rating (three had 7%, one had 13% reach a rating of 3). The sixth plot, Olevan Creek, had the highest defoliation rating for either an overstory or understory sample tree, 6, or 99% of the crown completely defoliated. One-third of sample understory trees in this plot had a 0 rating, 27% had a light rating, and the remaining 40% had moderate to high defoliation ratings.

Species Considerations

We looked at analysis areas where defoliated plots occurred, and looked at defoliation ratings in those plots by species. We excluded the South East analysis area because there is doubt over whether DFTM is responsible for overstory defoliation experienced there. Results are summarized in Tables 7 and 8.

Table 7. Defoliation results by species for analysis areas with plots experiencing overstory defoliation. Total trees column represents the total number of the species sampled in the entire analysis area. Row total is number of sampled trees with a defoliation rating >0.

Analysis Area	Species	Total Trees	Ratio of DF/GF	Trees by Defoliation Class							Row Total	Ratio Defoliated DF/GF
				1	2	3	4	5	6	7		
Gold Hill - Crane Point	DF	201	0.776062	11	11	6	2	1			31	0.525424
	GF	259		29	19	10	1				59	
McCrosky State Park	DF	41	2.157895	18	12	1	0	1			32	1.684211
	GF	19		6	7	6					19	
Moscow Mountain	DF	11	1.222222	8							8	2
	GF	9		3	0	1					4	

Table 8. Defoliation results by species for analysis areas with plots experiencing understory defoliation. Total trees column represents the total number of the species sampled in the entire analysis area. Row total is number of sampled trees with a defoliation rating >0.

Analysis Area	Species	Total Trees	Ratio of DF/GF	Trees by Defoliation Class							Row Total	Ratio Defoliated DF/GF
				1	2	3	4	5	6	7		
Gold Hill - Crane Point	DF	155	0.815789	8	2	3	0	0	2		15	0.405405
	GF	190		19	9	8	1				37	
McCrosky State Park	DF	22	0.956522	3	8	6	4				21	0.954545
	GF	23		10	6	2	4				22	
Moscow Mountain	DF	6	0.666667	4							4	1
	GF	9		3	0	1					4	

By comparing the ratio of DF/GF for all sampled trees in an analysis area to the ratio of defoliated DF/GF, it is possible to determine if one species is being defoliated at a higher rate than another. For both overstory and understory defoliated sample trees, in the Gold Hill analysis area, proportion of defoliated DF/GF is lower than the proportion of sampled DF to GF indicating that more grand fir trees are being defoliated than Douglas-fir trees. For McCrosky State Park analysis area, more overstory grand fir trees were being defoliated, but understory sample trees were fairly evenly distributed between Douglas-fir and grand fir. On the one sampled plot in Moscow Mountain more Douglas-fir were defoliated than grand fir.

To determine if Douglas-fir was more severely impacted, we compared the ratio of moderate-high (defoliation ratings of 3 or higher) DF/GF with the overall ratio of Douglas fir to grand fir. For Gold Hill analysis area, overstory Douglas-fir trees were slightly more heavily defoliated than grand fir trees (DF/GF ratio = .78 moderate-high DF/GF ratio = .81), and understory grand fir were more heavily defoliated than Douglas fir (DF/GF ratio = .82 to moderate-high DF/GF = .55). On McCrosky State

Park analysis area, overstory grand firs were more likely to be moderately defoliated than overstory Douglas-fir (DF/GF ratio = 2.16 mod-high DF/GF ratio = .33), and understory Douglas-firs were more likely to be heavily defoliated (DF/GF ratio = .96 moderate-high DF/GF = 1.66). Finally, in the Moscow mountain plot there were no moderate to high defoliated Douglas-fir and only 1 grand fir. With such a small sample it was not meaningful to compare.

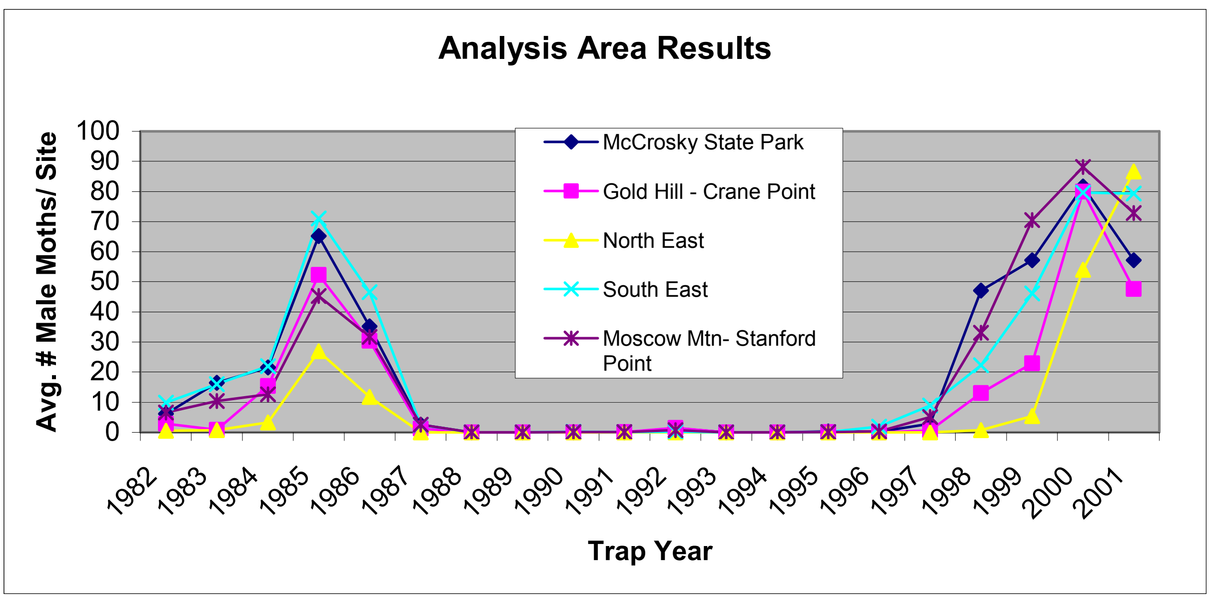
Douglas-fir Tussock Moth Population Trends

Early Warning System Pheromone Trapping Trends

In 2001, 69 of 93 DFTM early warning trap sites had average male moth catches (>25 average male moths/ trap) indicating high populations of DFTM and potential for continued defoliation in 2002 (Appendix 2). This year, 2001, is the fifth year in the current outbreak cycle in which multiple DFTM early warning sites have reached the threshold.

For three of the analysis areas (McCrosky State Park (max 11 sites), Gold Hill–Crane Point (max 4 sites), and Moscow Mountain to Stanford Point (max 18 sites)) there was a drop in average trap catches from 2000 to 2001; for the South East analysis area (max 11 sites) average trap catches remained static; for the North East analysis area there was an increase in trap catch from 2000 to 2001 (Figure 6).

Figure 6. Average pheromone trap catch for all sites in an analysis area 1982-2001, established long-term trap sites.



Though trap catches appear to be declining in three of the analysis areas, average trap catches in all analysis areas were far greater than the threshold of an average of 25 male moths per trap indicating high populations of DFTM and continued potential for defoliation in 2002. Early warning system trap results are most informative in years prior to visible defoliation. Once defoliation occurs, populations of DFTM are so high, and mechanisms for DFTM population collapse so unpredictable and potentially fast acting, that additional DFTM population estimates are necessary.

Early Larval Population Sampling

The percent reduction in early instar larval populations on Gold Hill and Crane Point control plots sampled was similar to the average percent larval reductions on plots treated with Bt (90% average reduction) and only slightly lower than on plots treated with Dimilin (95% average reduction) (Livingston 2001). Larval reductions on the plot in McCrosky State Park analysis area (46%) and the plot in Moscow Mountain analysis area (57%) are far less than reduction rates observed in treated areas (Table 9).

Table 9. Early larval sampling results for untreated control plots before and after insecticide applications on adjacent lands.

Township Range Section	Site Name (Analysis Area)	Pre Spray Total	Branch Average	Post Spray Total	Branch Average	% Reduction
40N 3W 6	Browns Meadow (Moscow Mountain)	667	133.4	289	57.8	57%
43N 4W 18	Mineral Mountain (McCrosky State Park)	263	52.6	141	28.2	46%
42N 4W 24	Gold Hill (Gold Hill-Crane Point)	714	142.8	66	13.2	91%
43N 4W 22	Crane Point (Gold Hill-Crane Point)	785	157	45	9	94%

Egg Mass and Cocoon Surveys

Table 10 summarizes egg mass and cocoon survey data by analysis area.

Table 10. Analysis area egg mass and cocoon survey summaries. Not all sampled semi-permanent plots had egg masses or cocoons.

Analysis Area	Total # Plots	# Plots 2001 Ems	# Plots Old Ems	# Plots Cocoons	Total 2001 Ems	Total Old Ems	Total Cocoons
Bargamin Bald	7	0	1	1	0	1	2
Gold Hill- Crane Point	23	22	12	23	293	62	1674
McCrosky State Park	3	3	3	3	47	48	678
Moscow Mountain	1	0	1	1	0	2	55
North East	11	2	0	8	4	0	41
South East	20	8	1	1	19	1	198

The number of plots in Bargamin Bald, North East, and South East analysis areas without current or old egg masses and the small totals of egg masses in these analysis areas suggests the population of DFTM in these areas is low and widely scattered. Significant defoliation and damage would not be expected in these analysis areas in 2002.

Predicted Population Trends, Current to Older Egg Mass Ratios

Nineteen of the 23 semi-permanent plots (83%) in the Gold Hill analysis area had increasing population trends going into the spring of 2002 (Table 11).

The average number of egg masses per plot in fall of 2001 is fairly low in the Gold Hill anslysis area (13) when compared to the number of egg masses in the fall of 2000 in McCrosky State Park and Moscow Mountain analysis areas before the defoliation of 2001 (many plots over 100 EMs, most over 20 EMs). Because the average number of egg masses per plot is relatively low on semi-permanent plots in the Gold Hill analysis area, we do not anticipate that there will be moderate to severe defoliation across a significant portion of NFS land in the analysis area in 2002.

Table 11: Analysis area summary of predicted population trends based on the ratio of current (2001) to older (2000) egg masses in semi-permanent plots. Plots without old or new egg masses were not considered (n= 29) and plots with new egg masses but no old egg masses were included in the increasing totals

Analysis Area	**Total # Plots**	**# Plots w/o New or Old Egg Masses**	**Predicted Population Trend (# Plots)**		
			Decreasing (Avg. Ratio)	**Static**	**Increasing (Avg. Ratio)**
Bargamin Bald	7	6	1 (0)	0	**0**
Gold Hill- Crane Point	23	2	1 (.375)	1	**19** (10(5.9) 9*(9.7)**)
McCrosky State Park	3	0	1 (0.47)	0	**2** (1.21)
Moscow Mountain	1	0	1	0	**0**
North East	11	9	0	0	**2*** (2)**
South East	20	12	0	0	**8** (1(8) 7*(1.6)**)

*Number of plots with 2001 egg masses but not 2000 egg masses;
** average number of egg masses on * plots.

One of the plots in the Gold Hill analysis area (#2 788E Gold Hill) experienced a 63% reduction in current egg masses from 2000 to 2001. The Bargamin Bald, McCrosky State Park, and Moscow Mountain analysis areas also had individual semi-permanent plots with decreasing population trends. This could indicate that natural DFTM population reduction factors may be beginning to have an impact in these analysis areas, and that an outbreak area wide DFTM collapse is imminent. Information from fall 2001 virus assays should indicate if virus may be playing a role in these isolated population reductions.

Most of the plots sampled in the Bargamin Bald, North East, and South East analysis areas did not have 2001 or older egg masses. Because so few of the plots in these analysis areas had a egg masses, we cannot draw accurate conclusions about the population trends in these analysis areas as a whole.

2002 Defoliation Predictions for 2001 Undefoliated Plots

The defoliation prediction model we used was developed for sites without noticeable defoliation so we applied it to the 50 semi-permanent plots that in 2001 had no defoliation ratings on overstory sample

trees. Shepherd et al. (1984) found in British Columbia that if during a fall egg masses survey, sample trees on a plot averaged 0 to 0.7 egg masses per 3 lower branches, than nil to light defoliation would occur the following summer; an average of 0.7 to 2.0 egg masses per 3 lower branches, noticeable defoliation; an average of 2.0 or more egg masses per three lower branches, then severe defoliation. Using these criteria (Appendix 3) defoliation predictions by analysis area are summarized in Table 12.

Table 12. Number of plots by defoliation prediction for analysis areas based on Shepherd et al. (1984) on plots that did not experience defoliation in sample trees in 2001.

Analysis Area	Total # Plots	# Plots Defoliated	2002 Expected Defoliation in Undefoliated Plots 2001 (Shepherd et al. 1984)		
			Nil-Light	Noticeable	Severe
Bargamin Bald	7	0	0	0	0
Gold Hill- Crane Point	23	8	13	1	1
McCrosky State Park	3	3	NA	NA	NA
Moscow Mountain	1	1	NA	NA	NA
North East	11	0	11	0	0
South East	20	3	15	0	0

Noticeable defoliation was predicted for 2002 in only two plots in the Gold Hill analysis area using this system. These plots are # 20 Crane Point (noticeable defoliation) and #7 Gold Creek (severe defoliation). This system was developed in British Columbia and previously has not been used in Idaho.

As a test of the system, we applied the same predictive model to egg mass data for 2000 (old egg masses) and excluded plots in the McCrosky and Moscow Mountain analysis areas, which were in aerially detected defoliation pockets in 2000. Using 2000 egg mass data, all plots in the remaining analysis areas had 2001 predicted defoliation in the nil-light range with the exception of plot # 2 788 East Gold Hill that had noticeable defoliation predicted for 2001. From the egg mass data, we know there was a substantial reduction in DFTM populations on plot # 2 East Gold Hill from 2000 to 2001, which may explain why the predicted defoliation did not materialize. This system was accurate because none of the plots that were defoliated in 2001 experienced severe defoliation, and defoliation in 2001 on all plots that experienced defoliation fell within the description of nil to light defoliation- e.g., not more than half the trees showed complete defoliation of current foliage in the upper crown, and only minor loss of old foliage.

Nucleopolyhedrosis Virus (NPV) Sampling

In 2001 we collected a maximum of two current egg masses from all semi-permanent plots that had current egg masses (Appendix 3). In 1999, Idaho Department of Lands collected egg masses from four sites, in 2000 Idaho Department of Lands collected egg masses from two sites and Forest Health Protection collected egg masses from two sites. NPV virus assay results are not yet available for egg masses collected in fall of 2001. Information from assays conducted on egg masses in 1999 and 2000 showed an increase from nothing in 1999 (Table 13) to a maximum of 0.9% in 2001 (Table 14).

Table 13. Natural occurrence of virus in egg masses collected in Idaho, 1999/2000.

Collection location	No. new egg masses reared	No. eggs reared	No. larvae emerged (%)	No. larvae reared for virus determination[a]	No. dead larvae[b]	No. dead larvae with NPV	Est. % NPV in pop. in 2000
ID-9	15	600	511 (85.2)	351	20 (5.8)	0 (0.0)	0.0
ID-12	15	603	550 (91.2)	377	15 (4.0)	0 (0.0)	0.0
ID-117	10	404	350 (86.6)	225	7 (3.2)	0 (0.0)	0.0
ID-216	10	401	376 (93.8)	250	12 (4.8)	0 (0.0)	0.0
Totals(x)	**50**	**2008**	**1787 (89.0)**	**1203**	**54 (4.6)**	**0 (0.0)**	**0.0**

[a] A maximum of 25 larvae from each egg mass were used for determining the natural occurrence of NPV.
[b] All dead larvae were examined.

Table 14. Natural occurrence of virus in egg masses collected in Idaho, 2000/2001.

Collection location	No. new egg masses reared	No. eggs reared	No. larvae emerged	No. Missing	No. Dead Larvae[c]	No. Dead Larvae with NPV	% Dead Larvae with NPV	Estimated % NPV Infection
Moscow Mtn.	49	1960	1165	7	80	1	1.3	**0.1**
Skyline Drive	46	1840	1143	4	125	10	8.0	**0.9**
Subtotal	95	3800	2308	11	205	11	5.4	**0.5**
Gold Hill	26	1040	650	14	36	2	5.6	**0.3**
Moses Mtn.	24	960	600	12	45	0	0.0	**0.0**
Subtotal	50	2000	1250	26	81	2	2.5	**0.2**
Total	**145**	**5800**	**3558**	**37**	**286**	**13**	**4.5**	**0.4**

We expect the percent of NPV infection will continue to increase in 2001/2002. If the level of naturally occurring NPV is between 20-30% among dead larvae reared in the assay, DFTM population in the area sampled is very likely to collapse (Otvos 2001). If NPV infection is below this threshold, it is still possible that DFTM populations may collapse from other natural causes (predators/ parasites or other diseases).

CONCLUSIONS

DFTM buildup apparently occurs simultaneously throughout suitable forest habitats in an area, and most favorable habitats for population growth probably reach the release phase first and suffer most severe defoliation during the outbreak phase (Wickman et al. 1973). In 2000, defoliation was most abundant in two analysis areas of the Palouse outbreak, McCrosky State Park and Moscow Mountain. Only minor defoliation was noted around Mica Mountain in the South East analysis area. Egg mass surveys in the fall of 2000 found the largest number of DFTM egg masses in Moscow Mountain and McCrosky State Park analysis areas. In 2001, aerial survey detected defoliation in other analysis areas, most notably Gold Hill, however, the most severe defoliation over the largest areas could still be found in Moscow Mountain and McCrosky State Park analysis areas.

Moscow Mountain and McCrosky State Park analysis areas were first to show defoliation in past outbreaks as well (Moscow Mountain analysis area 1944, 1961, 1973, 1986 and McCrosky State Park analysis area 1945, 1986 (Tunnock et al. 1985)) so these may be

the most favorable habitats for DFTM population growth on the Palouse Ranger District. Natural larval reduction rates collected in state control plots indicated while larval populations decreased by > 90% in the Gold Hill analysis area from natural causes, natural reduction rates in the Moscow Mountain analysis area was only 56%, and 46% in the McCrosky State Park analysis area.

Though aerial survey maps give the impression that defoliation is to be found throughout a mapped polygon, with DFTM moderate to severe defoliation occurs in discreet patches. In the discrete defoliated patches sampled on NFS lands, defoliation intensity was not particularly high. Only 10% of sampled overstory trees and 20% of sampled understory trees had defoliation in the moderate to high range. Less than one half of 1% of the overstory trees, and just over 1% of understory trees in plots with defoliation had ratings of 4 (top ¾ of the crown completely defoliated) or more.

Wickman (1979) conducted studies in the Blue Mountains of Oregon and found that the percentage of individual trees dying as a direct result of DFTM defoliation did not rise above 10% until reaching a defoliation rating of 5 (24% grand fir and 30% Douglas-fir trees with this rating died). Wickman also noted that interpreting ratings for individual trees can be deceiving as most mortality occurs in groups or patches of trees experiencing moderate to severe defoliation and extending over several acres or more. Trees defoliated 90% (defoliation rating of 5) or more and concentrated in patches have the highest probability of dying from defoliation. Trees defoliated 50% or less (defoliation ratings 1 or 2) rarely die from the effects of defoliation. None of the 2001 semi-permanent plots on NFS land had defoliation patterns consistent with areas described by Wickman that experienced mortality.

Sometimes bark beetles will attack overstory-defoliated trees. Wickman (1979) found that bark beetle attacks usually occur in trees defoliated 50-75% (defoliation rating 3) and do not develop spontaneously; there must either be a drought before or during an outbreak or a resident population of beetles that can respond. Weatherby et al. (1997) found, after an outbreak in southern Idaho that coincided with drought mortality in the 0-1 defoliation classes and the 2-4 defoliation class was fairly low and concentrated to the end of a 5-year post defoliation period.

Based on defoliation information collected on semi-permanent plots established on NFS lands, it is anticipated that mortality directly attributable to DFTM defoliation in 2001 and potential bark beetle response is going to be minimal. Olevan Creek had the highest defoliation intensity measured with 40% of sampled overstory and understory trees with defoliation ratings of 3 or higher, leaving 60% of sampled trees in a defoliation range where trees rarely die from effects of defoliation. There may be patches of moderate to severe defoliation that occurred in 2001 that were not sampled on NFS lands; we expect these patches are small in size, widely scattered, and few in number. Based on the DFTM literature, we estimate that only trees with a defoliation rating of 3 or higher may be at risk to direct DFTM mortality, or to mortality from bark beetles responding to DFTM defoliation. Trees fitting this description occurred on a small proportion of the semi-permanent plots sampled, and in those plots only represented 10% of sampled overstory trees.

In 2001 there was no consistent difference in frequency and level of defoliation between Douglas-fir and grand fir. Differences in defoliation by species seemed to vary with analysis area and size (overstory/understory).

Population estimates of DFTM in the fall of 2001 showed an increase in populations on the Gold Hill analysis area, and a widely scattered and fairly small population in the North East, South East, and Bargamin Bald analysis areas. Using the Shepherd et al. (1984) defoliation prediction system on undefoliated plots in these analysis areas in 2001, nil to light defoliation was predicted for all plots in the South East, North East, and Bargamin Bald analysis areas. In the Gold Hill analysis area, noticeable defoliation was predicted in one plot and severe defoliation (majority of trees had most of the current and one-half or more of older foliage missing, at least one-fifth of the trees were completely defoliated) was predicted in another. These defoliation levels would

be expected if a reduction in DFTM populations were not experienced in 2002.

In large outbreaks there may be considerable mixing of larvae so that separate population centers coalesce and end up behaving as a single population (Wickman et al., 1973). If this statement is accurate for the current outbreak on the Palouse, it is anticipated that defoliating populations of tussock moth that appeared in 2001 in the Gold Hill, North East, and South East analysis areas will collapse along with populations in Moscow Mountain and McCrosky State Park analysis areas. Populations in McCrosky State Park and Moscow Mountain analysis areas are expected to collapse soon, perhaps as soon as spring 2002, since those areas have experienced 2 years of significant defoliation.

LITERATURE CITED

Livingston, R.L. 2001. Douglas-fir tussock moth: results of 2001 spray project. In meeting notes of the Western North American Defoliator Working Group, John Wenz Chairman, Best Western University Inn, Moscow Idaho. November 6-8, 2001.

Otvos, I. 2001. DFTM Virus Detection Kit. In meeting notes of the Western North American Defoliator Working Group, John Wenz Chairman, Best Western University Inn, Moscow Idaho. November 6-8, 2001.

Randall, Carol. 2001. Douglas-fir tussock moth biological evaluation Palouse Ranger District, Clearwater National Forest-2000. USDA Forest Service Forest Health Protection Report 01-04.

Shepherd, R.F., I.S. Otvos, and R.J. Chorney. 1984. Pest management of Douglas-fir tussock moth (Lepidoptera: Lymantriidae): a sequential sampling method to determine egg mass density. Canadian Entomologist 116: 1041-1049.

Tunnock, S., M. Ollieu, and R.W. Their. 1985. History of the Douglas-fir tussock moth and related suppression efforts in the Intermountain and Northern Rocky Mountain Regions- 1927 through 1984. USDA Forest Service Intermountain and Northern Regions Report No. 85-13.

Weatherby, J.C., T. Barbouletos, B. Gardner, P. Mocettini. 1997. A follow up biological evaluation of the Douglas-fir tussock moth outbreak in Southern Idaho. USDA Forest Service Forest Health Protection Report R4-97-01.

Wickman, B.E. 1979. How to estimate defoliation and predict tree damage. USDA Combined Forest Pest Research and Development Program. Agriculture Handbook No.550.

Wickman, B.E., R.R. Mason, and C.G. Thompson. 1973. Major outbreaks of the Douglas-fir tussock moth in Oregon and California. USDA Forest Service General Technical Report PNW-5.

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APPENDIX 1. SEMI-PERMANENT PLOT LOCATIONS

Analysis Area	Plot No	Plot Name	Township	Range	Section
BB	65	Poorman Creek	37N	4E	24
BB	64	Mile Marker 22	37N	4E	23
BB	63	Gravel Pit	37N	4E	22
BB	62	Bargamin Creek	37N	4E	21
BB	61	Hollywood	37N	5E	9
BB	60	Calhoun Saddle	37N	5E	4
BB	59	Quartz Creek	37N	5E	5
GH	2	788E Gold Hill	42N	4W	NE24
GH	3	Olevan Creek	42N	4W	SW12
GH	20	Crane Point	43N	4W	23
GH	11	Last Chance Creek	42N	3W	SW18
GH	10	Lower Gold	42N	3W	NW19
GH	9	Upper Jerome	42N	3W	NW20
GH	8	Lower Jerome	42N	3W	20
GH	1	Jerome Thinning	42N	3W	29
GH	6	Wheelbarrow Mine Trail 215	42N	4W	SW1
GH	23	Hotelling	42N	4W	14
GH	5	Prospect Peak	43N	4W	36
GH	13	Hope Creek	42N	3W	SE6
GH	7	Gold Creek	42N	4W	NW2
GH	4	Waterhole Creek Trail #15	43N	4W	NW35
GH	24	Waterhole Creek	42N	4W	21
GH	12	Chelsay Creek Trail #19	42N	3W	5
GH	14	Junction 1924	42N	3W	SW8
GH	15	East Gold Creek Seed Tree	42N	4W	NE11
GH	16	Treasure Gulch #1	42N	4W	N3
GH	17	Treasure Gulch #2	42N	4W	SE11
GH	18	East Gold Trail #215	42N	4W	13
GH	19	Jerome Creek Boundary	42N	3W	28
GH	21	Crane Point Jct	43N	4W	E27
MC	26	Mission Mountain	43N	5W	SW22
MC	25	Corinth Trail Head	43N	4W	SW18
MC	22	McKrosky	43N	4W	19
MM	27	Brown's Meadow	40N	3W	NW6
NE	43	Feather Creek 2	42N	1W	36
NE	42	Bovill Highway	42N	1E	32
NE	44	Feather Creek 1	41N	1W	1
NE	45	Bald Mtn Trail	43N	2W	34
NE	46	Little Bald Mtn	42N	2W	3
NE	47	4710 Little Bald	43N	2W	1
NE	48	Upper Wepah	42N	2W	33
NE	49	Laird Park	42N	3W	31

Analysis Area	Plot No	Plot Name	Township	Range	Section
NE	57	W. Fork Potlatch Creek	41N	1W	1
NE	58	Excevation Gulch	42N	2W	9
NE	41	Porcupine Creek	42N	1E	31
SE	34	Road 3801	41N	2E	35
SE	38	Tick Ridge	39N	2E	3
SE	56	Potato Hill	40N	2W	3
SE	55	Little Bear Creek	41N	2W	35
SE	54	Cougar Ranch	40N	1W	28
SE	53	Lower North Park	40N	1W	34
SE	52	Little Boulder Creek	40N	1W	35
SE	51	Little Boulder Upper Rock Pit	40N	1W	27
SE	50	Little Boulder CG	40N	1W	33
SE	32	Junction 3205	40N	2E	3
SE	39	Elk Creek Falls	39N	2E	11
SE	28	Corral Creek	40N	2W	1
SE	37	Lindly Creek	40N	2E	34
SE	36	Robideaux Meadows	39N	2E	2
SE	35	Johnson Creek	40N	2E	2
SE	33	Morris Creek	41N	2E	33
SE	31	1969 Road	41N	2E	34
SE	30	Wet Meadows	41N	2W	36
SE	29	Vassar Meadows	40N	2W	NE2
SE	40	Elk River Pond	40N	2E	35

APPENDIX 2. Northern Idaho 2001 Douglas-fir Tussock Moth Early Warning Trapping System Report - Carol Randall , Larry Stipe, and Doug Wulff

Executive Summary

In 2001, 60 of 93 Douglas-fir tussock moth early warning trap sites had average male moth catches (>25 average male moths/ trap) indicating high populations of the tussock moth and potential for continued defoliation in 2002. 2001 is the fifth year in the current outbreak cycle in which multiple tussock moth early warning sites have reached the threshold, and it was the second year of aerially visible Douglas-fir tussock moth defoliation.

Idaho Department of Lands conducted a cooperative Douglas-fir tussock moth aerial suppression project on 76,492 acres of state and private land in the spring of 2001.

While early warning traps are still indicating high Douglas-fir tussock moth populations, additional population estimates are needed to determine if and where significant defoliation will occur in 2002. Early warning system trap results are most informative in the years prior to visible defoliation. Once defoliation occurs, populations of tussock moths are so high, and mechanisms for tussock moth population collapse so unpredictable and potentially fast acting, that additional tussock moth population estimates are necessary.

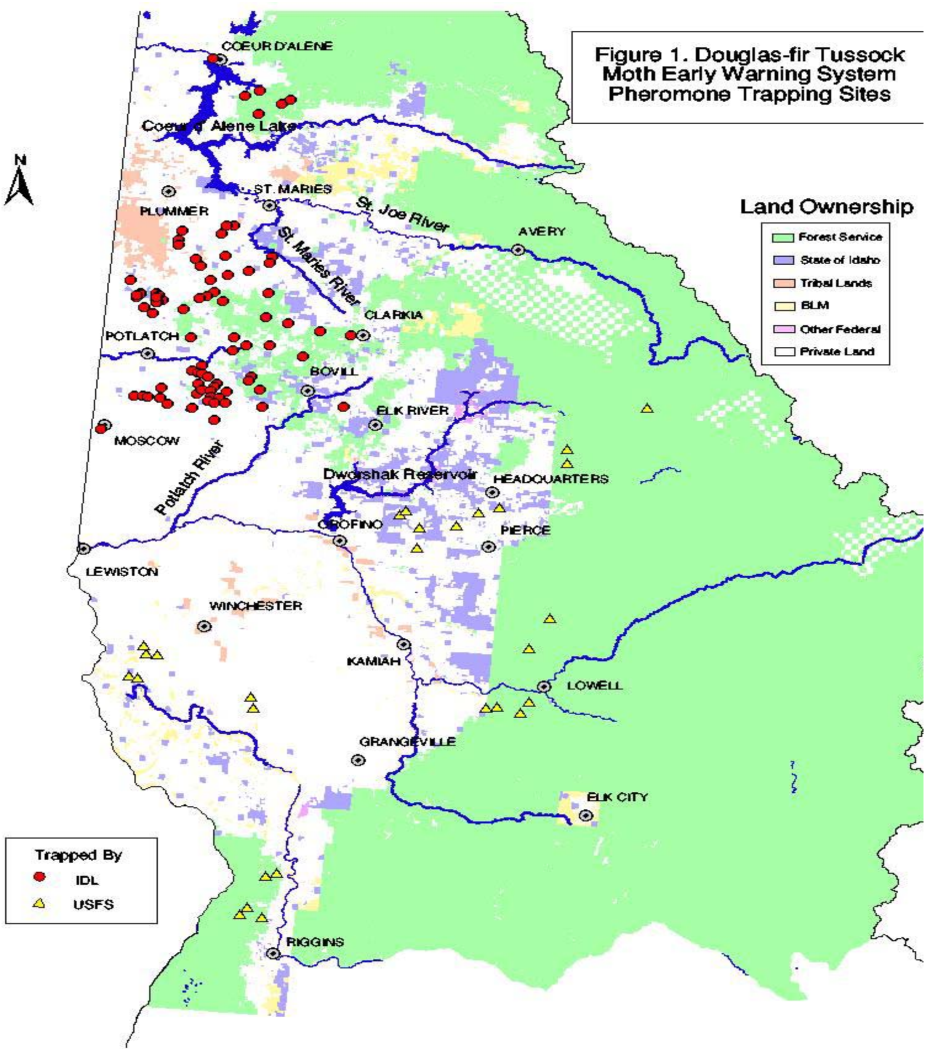
In the fall of 2001 Forest Service and Idaho Department of Lands crews conducted Douglas-fir tussock moth egg mass surveys to identify areas with high tussock moth egg mass densities. Areas with numerous current-year egg masses are most likely to experience defoliation in 2002. Egg mass survey results will be analyzed and will be results summarized in other reports.

Introduction

The Douglas-fir tussock moth Early Warning System in northern Idaho is a cooperative effort between Forest Service and Idaho Department of Lands. This system uses a series of permanent pheromone trapping sites to identify increasing populations of tussock moth prior to a defoliation event. Idaho Department of Lands maintains Douglas-fir tussock moth trap sites in townships 39N north to township 50N; Region 1 of the Forest Service maintains trap sites from township 39N south to township 25N (Figure 1). Similar Douglas-fir Tussock Moth Early Warning systems are in place in other western states.

A pheromone trap site consists of five traps baited with Douglas-fir tussock moth sex pheromone. Male moths are attracted to the traps. Once the average trap catch on a site reaches 25 male moths/trap, additional population sampling is conducted in areas of concern around the trap site to determine if defoliation is likely the following year. Additional population sampling may include egg mass surveys, or early larval sampling the following spring.

Figure 1. North Idaho Douglas-fir tussock moth early warning system pheromone trapping sites.



Recent Douglas-fir Tussock Moth Trapping Trends

In 1997, 2 trap sites out of 102 placed in northern Idaho had average male moth counts greater than or equal to 25. Both of these sites were in Township 43N (Range 3W and 4W) (Figure 2). In 1998, the number of sites with greater than or equal to 25 male moths per traps jumped to 25, indicating a need to conduct ground sampling to assess potential for defoliation in the near future. The 25 sites were scattered from Township 40N the Township 43N, and Range 2W to 5W (Figure 3). The number of sites reaching an average of 25 male moths per trap continued to increase through 2000 (Table 1) and could be found from Townships 39N to 46N, and ranges 7W to 1E (Figures 4-5).

Table 1. Number of trap sites monitored and number of sites with an average trap catch of 25 or more male moths 1996-2000.

	1996	**1997**	**1998**	**1999**	**2000**
Total Trap Sites	101	102	100	95	101
Site Average > = 25	0	2	25	34	59

Defoliation

Aerially visible defoliation was first noted on approximately 54,700 acres around Moscow Mountain and Mary Minerva McCrosky Memorial State Park in 2000 (townships 39N to 44N, ranges 6W to 1W) (Figure 5). Egg mass surveys conducted in the fall of 2000 found the highest concentration of egg masses in these two areas, but egg masses could be found in surrounding areas at lower densities.

Based upon this information, Idaho Department of Lands prepared for and conducted an aerial spray program on state and private lands in the spring of 2001. In 2001, the amount of aerially visible defoliation increased to 141,900 acres and covered area from Townships 39N to 46N and Ranges 6W to 2E (Figure 6).

Figure 2. 1997 Northern Idaho Douglas-fir tussock moth early warning system pheromone trapping sites. Sites in red had an average of 25 or greater male moths per trap, an indication of increasing populations that may result in defoliation.

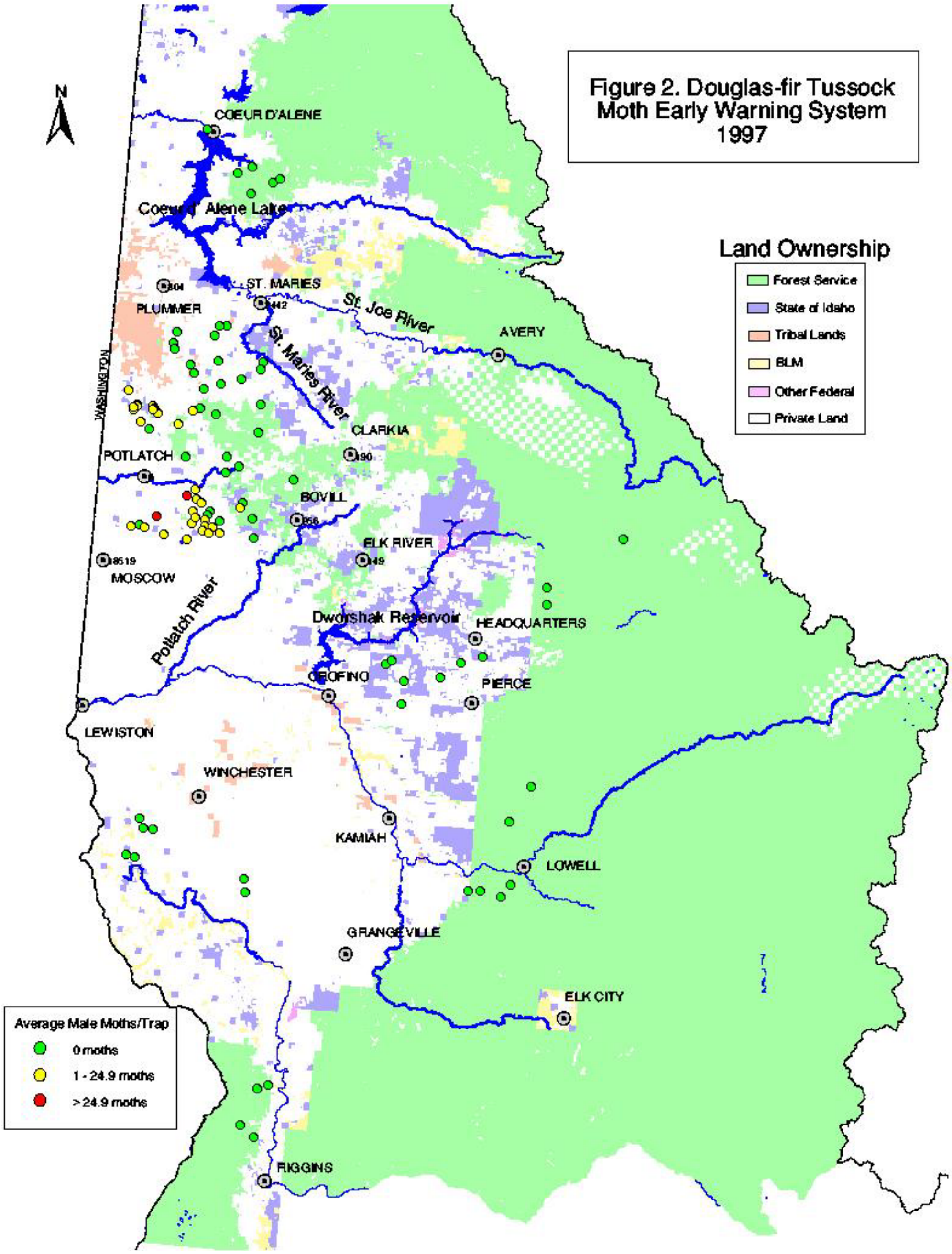


Figure 3. 1998 Northern Idaho Douglas-fir tussock moth early warning system pheromone trapping sites. Sites in red had an average of 25 or greater male moths per trap, an indication of increasing populations that may result in defoliation.

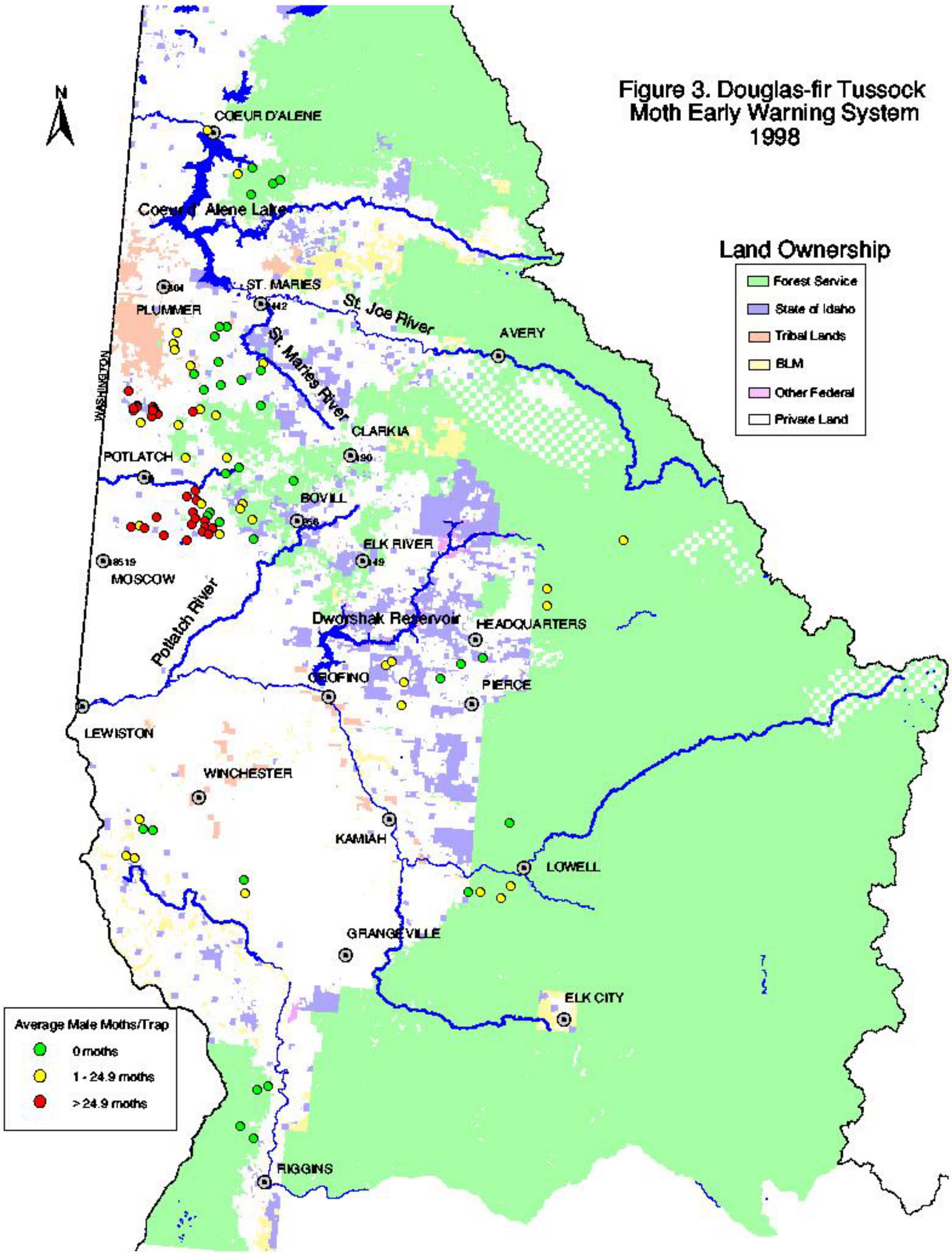


Figure 4. 1999 Northern Idaho Douglas-fir tussock moth early warning system pheromone trapping sites. Sites in red had an average of 25 or greater male moths per trap, an indication of increasing populations that may result in defoliation.

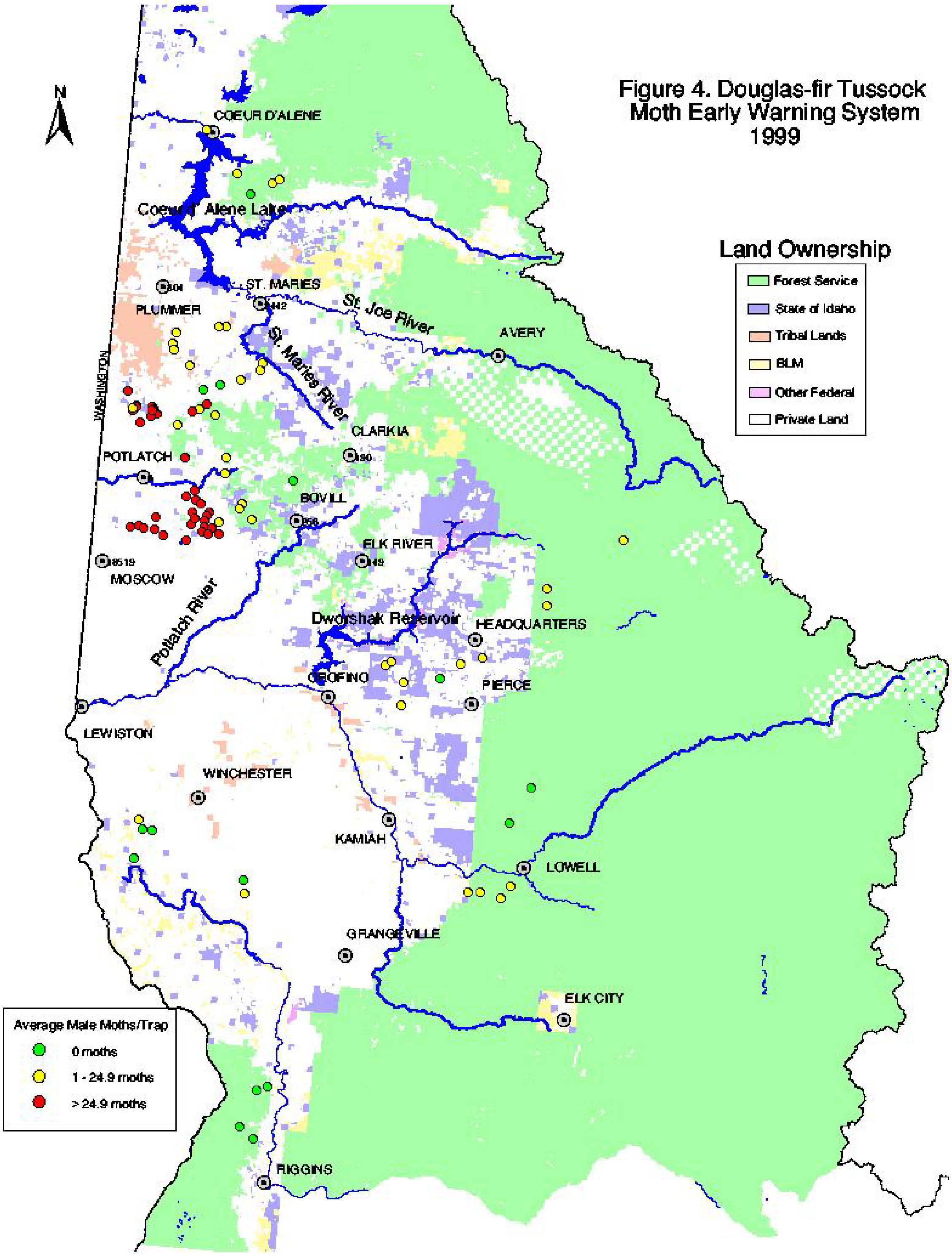
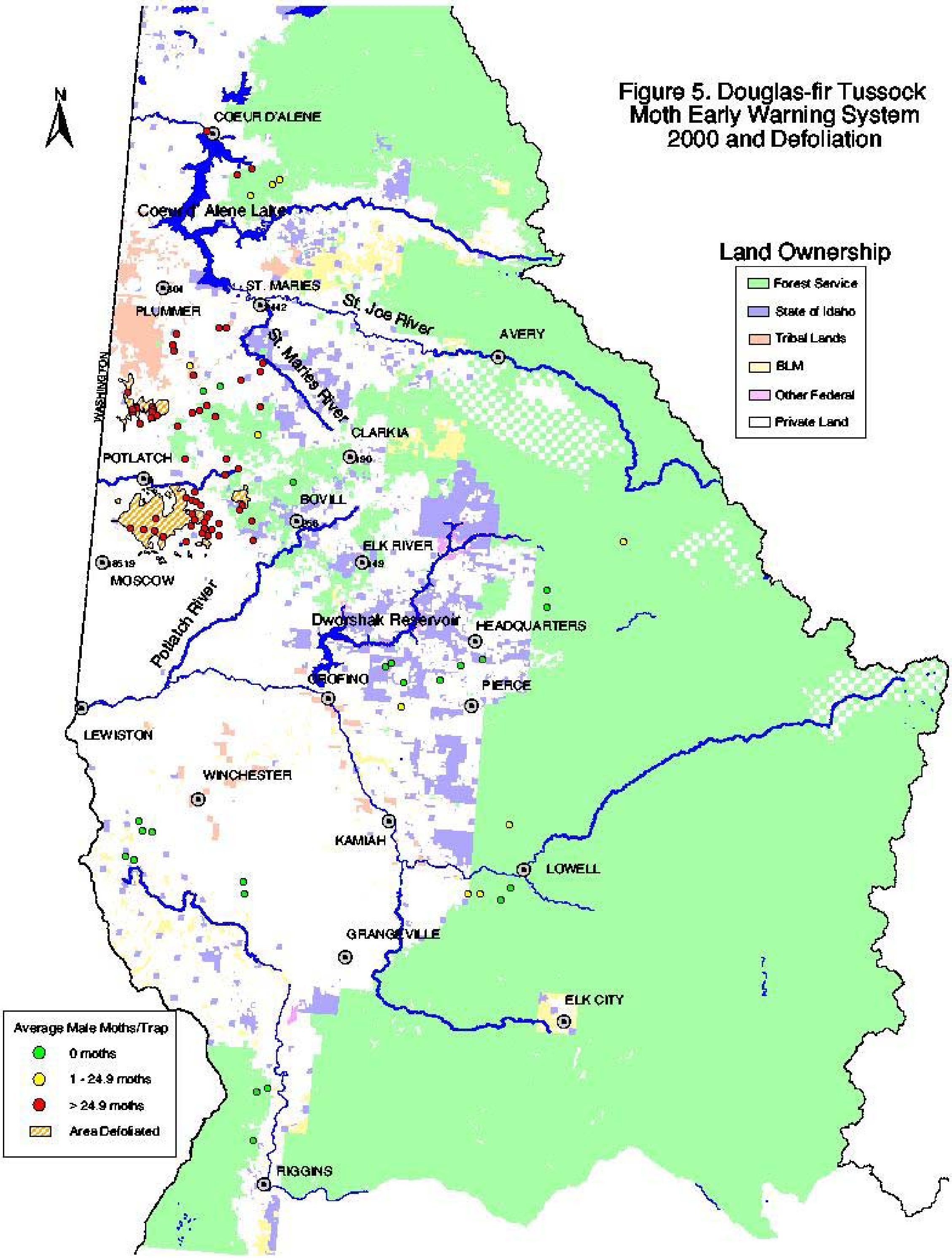


Figure 5. 2000 Northern Idaho Douglas-fir tussock moth early warning system pheromone trapping sites and aerially visible defoliation (approximately 54,000 acres). Trap sites in red had an average of 25 or greater male moths per trap, an indication of increasing populations that may result in defoliation.



2001 Information

In 2001, 60 early warning trap sites out of 93 monitored had > or = 25 male tussock moths/trap (Figure 6). The area in which traps exceeded threshold was divided into five analysis areas: McCrosky State Park, Gold Hill to Crane Point, Moscow Mountain to Stanford Point, North East, and South East (Figure 7).

Figure 6. 2001 Northern Idaho Douglas-fir tussock moth early warning system pheromone trapping sites and aerially visible defoliation (approximately 142,000 acres). Trap sites in red had an average of 25 or greater male moths per trap, an indication of increasing populations that may result in defoliation.

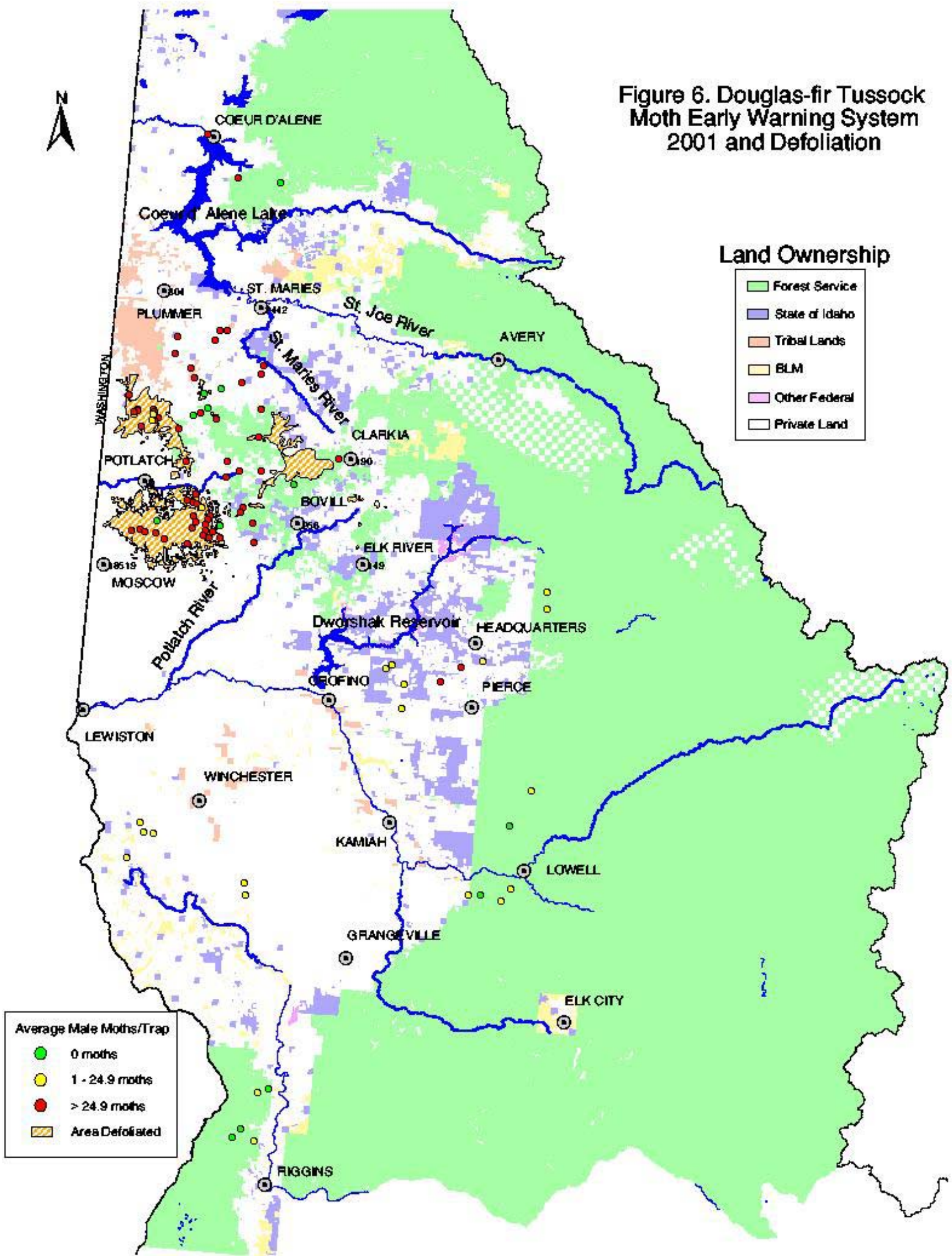
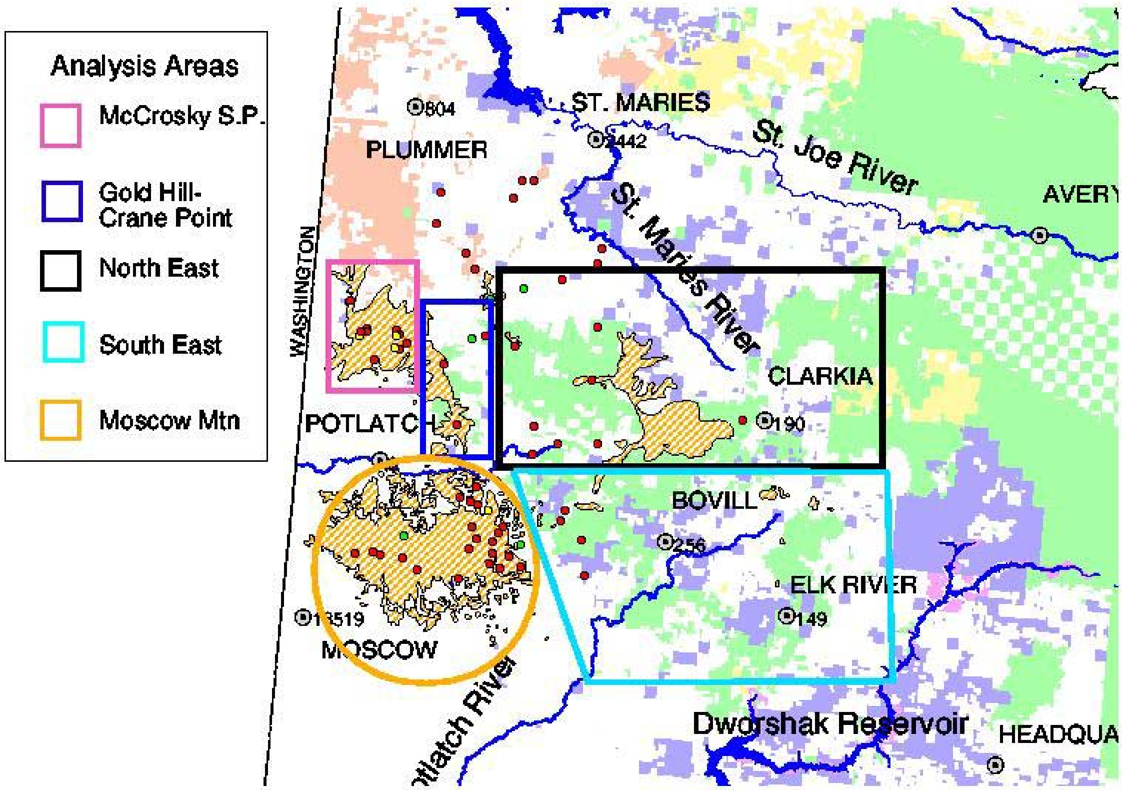


Figure 7. Analysis Area Boundaries in areas where Douglas-fir Tussock Moth Early Warning System Traps Exceeded Threshold (>= 25 male moths/ trap) in 2001.

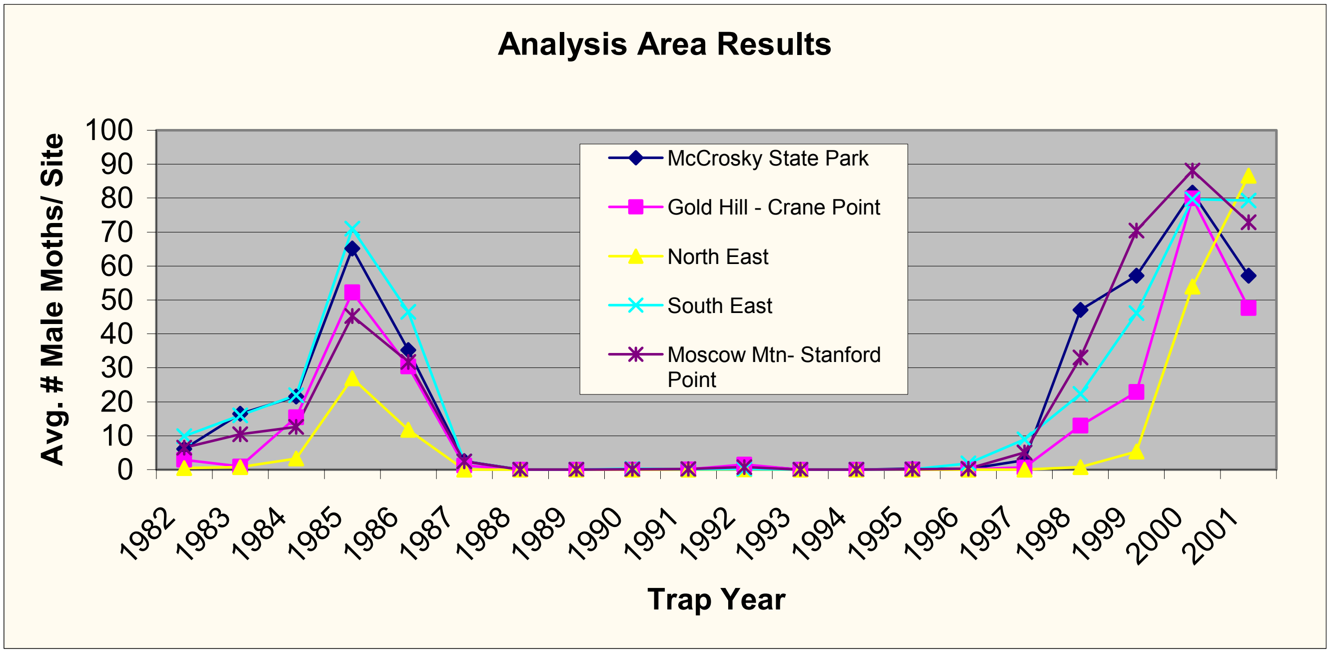


Pheromone trap sites that fell in these analysis areas were divided out from the rest of the early warning system and their trap catch trend analyzed. For three of the analysis areas (McCrosky State Park (max 11 sites), Gold Hill – Crane Point (max 4 sites), and Moscow Mountain to Stanford Point (max 18 sites)) there was a noted drop in the average trap catches from 2000 to 2001; for the South East analysis area (max 11 sites) average trap catches remained static; for the North East analysis area there was an increase in trap catch from 2000 to 2001 (Figure 8).

Though trap catches appear to be declining in three of the analysis areas, average trap catches in all analysis areas were far greater than the threshold of an average of 25 male moths per trap indicating high populations of the Douglas-fir tussock moth and continued potential for defoliation in 2002. Additional population sampling is necessary to determine if defoliation is likely and where it may occur.

Idaho Department of Lands and the Forest Service are currently conducting egg mass surveys to address the potential for defoliation in 2002. Results from these surveys should be available this winter.

Figure 8. Average pheromone trap catch for all sites in an analysis area 1982-2001, established long-term trap sites.



Additional Areas of Concern

Two early warning trap sites south and east of the identified analysis areas (Bargamin Creek (township 37N range 4E) and Bald Mountain (township 37N range 5E)) had average trap catches in excess of 25 in 2001 (Figure 6). Field crews took information on seven plots in the vicinity of Bargamin Creek and Bald Mountain and only found one old (2000) tussock moth egg mass and two cocoons of undetermined age.

Though tussock moths are present in the area of Bargamin Creek and Bald Mountain, severe defoliation is unlikely in this area in 2002.

Conclusions

The results of the 2001 Douglas-fir tussock moth early warning trapping efforts are difficult to evaluate since much of the area trapped is in the middle of a Douglas-fir tussock moth outbreak. The purpose of the early warning system is to give land managers advance notice of increasing populations of Douglas-fir tussock moths that may result in visible defoliation. The system was effective, giving 2 to 3 years' notice of increasing tussock moth populations before visible defoliation was evident. Once an outbreak is in progress, however, the utility of the trapping system is diminished. High populations of male moths can overwhelm monitoring traps and can cause traps well outside the eventual boundaries of defoliation to register warnings. Once visible defoliation is present, it is important that ground surveys focusing on other life stages, such as egg masses or early instar larvae, be conducted to determine distribution and density of tussock moth populations.

APPENDIX 3. Semi-permanent Plot Egg Mass/Cocoon Data (highlighted plots had measurable defoliation on at least one sample overstory tree).

Analysis Area	Plot No	01 Ems	Shep.	Old Ems	Old Shep	01/Old EM	Cocoons
Bargamin Bald	59	0	0	0	0	None	0
Bargamin Bald	60	0	0	0	0	None	0
Bargamin Bald	61	0	0	0	0	None	0
Bargamin Bald	62	0	0	0	0	None	0
Bargamin Bald	63	0	0	1	0.05	0	0
Bargamin Bald	64	0	0	0	0	None	2
Bargamin Bald	65	0	0	0	0	None	0
Gold Hill	1	5	0.25	0	0	None	32
Gold Hill	10	2	0.1	2	0.1	1	34
Gold Hill	11	24	1.2	4	0.2	6	80
Gold Hill	12	4	0.2	2	0.1	2	9
Gold Hill	13	8	0.4	1	0.05	8	22
Gold Hill	14	1	0.05	0	0	None	10
Gold Hill	15	7	0.35	0	0	None	27
Gold Hill	16	26	1.3	2	0.1	13	76
Gold Hill	17	23	1.15	5	0.25	4.6	77
Gold Hill	18	3	0.15	1	0.05	3	34
Gold Hill	19	1	0.05	0	0	None	15
Gold Hill	2	9	0.45	24	1.2	0.375	62
Gold Hill	20	14	0.7	0	0	None	30
Gold Hill	21	46	2.3	7	0.35	6.5714286	238
Gold Hill	23	8	0.4	1	0.05	8	60
Gold Hill	24	5	0.25	0	0	None	13
Gold Hill	3	38	1.9	7	0.35	5.4285714	590
Gold Hill	4	15	0.75	6	0.3	2.5	87
Gold Hill	5	0	0	0	0	None	6
Gold Hill	6	1	0.05	0	0	None	8
Gold Hill	7	44	2.2	0	0	None	127
Gold Hill	8	2	0.1	0	0	None	22
Gold Hill	9	7	0.35	0	0	None	15
McCrosky S.P.	22	21	1.05	17	0.85	1.2352941	313
McCrosky S.P.	25	7	0.35	15	0.75	0.4666667	140
McCrosky S.P.	26	19	0.95	16	0.8	1.1875	225
Moscow Mtn	27	0	0	2	0.1	0	55
North East	41	0	0	0	0	None	1
North East	42	0	0	0	0	None	0
North East	43	0	0	0	0	None	0
North East	44	0	0	0	0	None	2
North East	45	0	0	0	0	None	2
North East	46	0	0	0	0	None	19
North East	47	1	0.05	0	0	None	2
North East	48	0	0	0	0	None	0

Analysis Area	Plot No	01 Ems	Shep.	Old Ems	Old Shep	01/Old EM	Cocoons
North East	49	3	0.15	0	0	None	11
North East	57	0	0	0	0	None	3
North East	58	0	0	0	0	None	1
South East	28	0	0	0	0	None	3
South East	29	2	0.1	0	0	None	38
South East	30	2	0.1	0	0	None	21
South East	31	1	0.05	0	0	None	4
South East	32	0	0	0	0	None	2
South East	33	0	0	0	0	None	0
South East	34	1	0.05	0	0	None	5
South East	35	0	0	0	0	None	3
South East	36	0	0	0	0	None	0
South East	37	0	0	0	0	None	0
South East	38	0	0	0	0	None	0
South East	39	0	0	0	0	None	0
South East	40	0	0	0	0	None	0
South East	50	0	0	0	0	None	5
South East	51	1	0.05	0	0	None	3
South East	52	0	0	0	0	None	0
South East	53	1	0.05	0	0	None	23
South East	54	0	0	0	0	None	6
South East	55	8	0.4	1	0.05	8	64
South East	56	3	0.15	0	0	None	21